

KEY TELEPHONE SYSTEMS

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1. GENERAL

1.1 This section provides REA borrowers, consulting engineers, and other interested parties with information for use in the design, construction, and operation of REA borrowers' telephone systems. It discusses the application and engineering considerations for key, or multiline, telephone systems. This section replaces Issue No. 1 dated May 1959.

1.2 This section updates information on the use and engineering of key systems. It also deletes information on PBX equipment which will be covered in another section.

1.3 The key telephone system consists of multiline key telephone sets, with or without associated relay equipments, which enable the user to pick up and hold two or more PBX or central office lines, and includes supervisory lamp signals at the telephone sets. Intercommunication service may also be provided between the multiline telephone sets. In addition, other options such as access to paging facilities, conference calling, and privacy features are available, if desired.

2. KEY SYSTEM CAPABILITIES

2.1 Fundamentally key systems can be broken down into very simple systems, usually up to three lines, where all the switching functions are contained within the telephone as shown in Figure 1, and more complex systems requiring auxiliary cabinets (known as key service units) to house the key system circuits (known as key telephone units) as shown in Figure 2. In addition there are several types of intercoms available, as well as a number of other special features and optional equipment.

2.2 At present, due to copyright laws and other factors, there is considerable confusion in the use of terminology for the different types of key telephone systems. Therefore, in this section the simple multiline system, employing "hold" and "line" keys for each line, and requiring no relay equipment mounted externally to the telephone sets, will be called Type A key systems. Larger, more complex, systems employing the key service unit and multiple key telephone units will be called the Type B key systems.

2.3 Type A Key Telephone Systems. Type A multiline telephone systems have an individual hold key and line key for each line and do not require a key service unit. While usually less expensive and easier to install than the more elaborate Type B key systems, the simple Type A system lacks some of the options and the flexibility of the larger systems. The simple Type A key telephone system, as illustrated in Figure 1, is more economical than the more complex systems, yet permits the telephone user to share in the use of several lines.

2.31 Because Type A telephone systems do not require control circuitry, the normal installation requires only two pairs for each line - one pair as a talking path, and one for signal lamps associated with the line. If lamp supervision is not required, this can be reduced to a single pair per line, thus producing an extremely simple installation.

2.32 One example of the inflexibility of the Type A telephone system is the mode of applying the hold feature. In most of these systems this is done by mechanically switching a resistor across the line to be held. This is done at the set placing the line on hold. As a result, while any other set having access to the line may pick up and talk on it, the line cannot be released at the end of a call until the hold is terminated at the set that placed the hold. As the hold key is normally connected to the hook switch, this condition is fulfilled when the set is placed on hook.

2.33 In spite of the limitations of Type A systems, when a low cost, simple installation is desired, the Type A system should be considered.

2.4 Type B Key Telephone Systems. The Type B key system, employs a key service unit to house extra control circuitry, is more complex but more flexible than the Type A key telephone system. When more features are desired, or more than three lines must appear at each set, a Type B key telephone system, as illustrated in Figure 2, should be employed. These systems, while more expensive and requiring a more complex installation, offer many more options and far greater flexibility of service than the Type A key systems.

2.5 Intercommunication Systems. There are two categories of intercom systems available for use with key telephone systems under discussion. They include:

- a. The common talking path system which can be either dial or manual and which provides an intercom "party line" between all stations.
- b. The private talking link system or Private Automatic Exchange (PAX) which provides one or more dial up private talking links between the stations. The PAX may be large and may serve to interconnect several key systems, yet of itself it cannot access the dial network.

2.51 The common talking path intercom system is the simplest available.

In its simplest form, buzzers employing manually coded buzzing to identify the called station, are used to notify that station to pick up the intercom. An alternate to this is the dial actuated buzzer in which only the buzzer at the called station is activated when the calling station intercom key is depressed and the number assigned to the called station is dialed.

2.511 The common talking path type of the intercom is more useful when the intercom is used only to alert personnel to incoming calls, or to summon them to meetings. When extended conversations between intercom stations are the normal mode of operation, the common talking path is not recommended.

2.512 For small systems, with few stations, or if personnel frequently cannot be reached at a given station, the external buzzer and code buzzing are recommended. In this way, the code can be assigned to a person and, should they be near any telephone connected to the intercom, they will be alerted when needed. If personnel are normally available at a given station and if code buzzing will provide an annoying distraction, the dial-up buzzer should be used.

2.52 The private talking link or PAX form of intercom is considerably more complex than the common talking path system. It provides one or more private dial-up talking links which operate in much the same way as a small central office. While some forms of conferencing are available as options on these systems, their primary objective is to provide privacy for extended conversations between two stations. This form of intercom is considerably more complex than the common talking path system, yet there are situations where it is strongly recommended.

3. OPTIONAL FEATURES

3.01 From a selection of almost no options when key systems were first introduced, the choices presently available have grown greatly, and more items are being added continuously. Before attempting to discuss key system options with a potential customer, the telephone company representative should become familiar with the options and capabilities of units offered by the various manufacturers. The following are brief discussions of some options presently available.

3.02 Busy-Station Number Display. This device is a unit that indicates what stations on a system are off hook. It is generally used by a receptionist prior to alerting the called station to a call.

3.03 Camp-on Busy. When all talking paths are busy in the PAX type intercom, and an intercom call is attempted, the system stores the called number and, as soon as a talking path becomes free, completes the call.

3.04 Conference Calling. This option permits the bridging of several CO lines, a CO line and several intercom only stations, or combinations thereof. The capabilities of conference systems vary widely, so the system manufacturer's literature should be checked carefully for an exact knowledge of what can be done.

3.05 Exclusion. This provides the ability of a certain station to prevent other stations from accessing a line which is in use by the excluding station. The initiation of the exclusion may be manual, requiring pulling up a button at the excluding station, or automatic when the excluding station goes off-hook. Selective exclusion can be provided whereby, for example, the company president excludes all others from lines appearing on his set, the vice-president excludes all but the president, etc.

3.06 Night Call Adapter. This circuit causes incoming calls to cause a bell to ring at a station not normally used to answer incoming calls during working hours. It may be employed to permit a guard or night attendant to answer calls from several systems during periods when the normal positions are unattended.

3.07 Off Premise Extension Adapters. Most key systems have a very restrictive loop resistance limit on signaling. Fifty ohms (about 1000' of 24 gauge cable) is not uncommon. As a result when stations beyond this limit are desired, special range extenders must be employed. Any telephone plant exposed to the elements as a result of long extension runs should be constructed to normal outside plant standards and fitted with electrical protection if required.

3.08 Paging Access. This option permits the subscriber to access a public address system and use the telephone transmitter as the microphone for access to the PA loudspeakers.

3.09 Private Line Circuit. This provides a direct connection between two stations. Various methods of access and signaling are available.

3.10 Pushbutton Dialing. Most key systems are designed to operate only with rotary dial telephones unless a pushbutton dial (PBD) adapter is added. In some systems, the conversion to PBD must be 100 percent; i.e., the system will operate with either PBD or rotary dial, but not a mixture of the two.

3.11 Ringling During Local Power Outage. This option bridges ringers across CO/PABX lines during a local power failure to allow signaling of incoming calls.

4. PLANNING A KEY SYSTEM INSTALLATION

4.1 In planning a key system installation the telephone company representative should carefully discuss the proposed installation with the customer. Items to be covered in this discussion are listed in Table 1.

4.11 Traffic. How many CO or PABX lines will be required to handle the anticipated volume of calls? How many and what kind of intercom systems will be required? If the customer presently has a system in use, traffic studies on this system may be used as a basis for estimating requirements for the new system.

4.12 Future Expansion. Discuss the customer's plans for expanding his business and try to see if the proposed key system can be engineered to fulfill the requirements for a reasonable period of time.

4.13 Customer Desired Features. Ask the customer what options, as covered in Paragraph 3, he would like to have incorporated in the installation. The telephone company representative must be knowledgeable in the options available with the systems he markets so that he may guide the customer's selections.

4.14 Recommended Features. The telephone company representative should determine how the customer intends to use the system. Then, the representative should attempt to guide the customer to those features and options which will make the application more efficient.

4.15 Off Premises Stations. While it is possible with modern key equipment to locate Key system stations at considerable distances from the key service unit, this may not be the most economically effective method of operation. One objection is the long runs of multipair cable (up to 50 pairs for a 12 button set). Another consideration is electrical protection when the cable to the off premise station is exposed to lightning and power contacts. For the 12 button set just mentioned, the cable would have to be protected at each end, requiring a total of 100 pairs of protectors. One possible compromise in this situation would be to extend only the intercom and perhaps one CO or PABX line to the remote station. This would give a limited service capability while drastically reducing cable and protection requirements.

4.16 Cable Runs and Loop Limits. Most present day key systems have a loop limit of approximately 50 ohms or less from the key service unit to any station unless a range extender is used. Most present day key systems also require the use of large multipair cables. As a result, much care should be given to placing the cable in such a manner as to obtain short runs while assuring that this placement is not objectionable to the customer.

4.17 Key Service Unit (KSU) Location and Power Supply. As the KSU will require ac power, space should be provided for this device in an inconspicuous location near a power outlet. The power cord should be firmly attached to the outlet. Several possible locations should be considered when planning cable runs, and the objective of keeping these short should enter into KSU location.

TABLE I

Key System Installation Checklist

TRAFFIC
FUTURE EXPANSION
CUSTOMER DESIRED FEATURES
RECOMMENDED FEATURES
OFF PREMISES STATIONS
CABLE RUNS AND LOOP LIMITS
KEY SERVICE UNIT LOCATION AND POWER SUPPLY

4.2 The interdependence of these factors is illustrated in the following examples of key system installations.

4.21 A physician's office, as illustrated in Figure 3, could be well served by a simple multiline telephone system. The doctor in this example employs a receptionist and a nurse. The normal operational routine of the office is as follows:

4.211 Receptionist:

- a. Answers all incoming calls
- b. Makes appointments
- c. Refers urgent calls to doctor
- d. Maintains files (brings additional data to doctor upon request)

4.212 Nurse

- a. Assists doctor

4.213 Doctor

- a. Examines patients alternately in examination rooms 1 and 2, then discusses results in office.
- b. Places calls to hospitals and other physicians for consultation and to determine availability of necessary facilities.

4.214 Traffic studies of similar facilities in the area have shown that two central office lines will be adequate for normal traffic. No future expansion is anticipated.

4.215 The resulting installation could be as follows:

4.2151 A Type A system using four three-line telephone sets, one for the receptionist, one in the doctor's office, and one in each examining room.

4.2152 Each set should be connected to the two CO lines required for the amount of traffic anticipated, and the third line capability of the sets should be assigned to a common talking path intercom.

4.2153 External buzzers should be located at each station, and buzzer codes assigned to members of the staff so that they can be alerted to incoming calls regardless of their location in the office.

4.22 A large grain elevator installation is illustrated in Figure 4. Running through the list in Table 1 yields the following:

4.221 Traffic. Based on other similar installations in this area and the present level of staffing, four CO lines should be sufficient, but -----.

4.222 Future Expansion. A 50 percent increase in staff and workload is expected within a year. Thus this extra traffic must be considered, requiring six CO lines. This means 10 or 12 button multi-line telephone sets must be used.

4.223 Customer Desired Features

4.2231 Since the office will be normally manned for only a 40-hour work week, a night call adapter must be provided to switch all incoming calls to the guard hut, which will be manned at all times.

4.2232 The telephone at the elevator is beyond the signaling limits of the key system employed, so an off premises extension adapter is required. When the cost of installing a 25 or larger pair cable and protection to serve this facility was mentioned, the elevator manager elected to make this a single line intercom station.

4.2233 The manager periodically makes calls which he does not want to be overheard by other employees. As a result, at least one line on his telephone should be equipped for exclusion.

4.224 Recommended Features

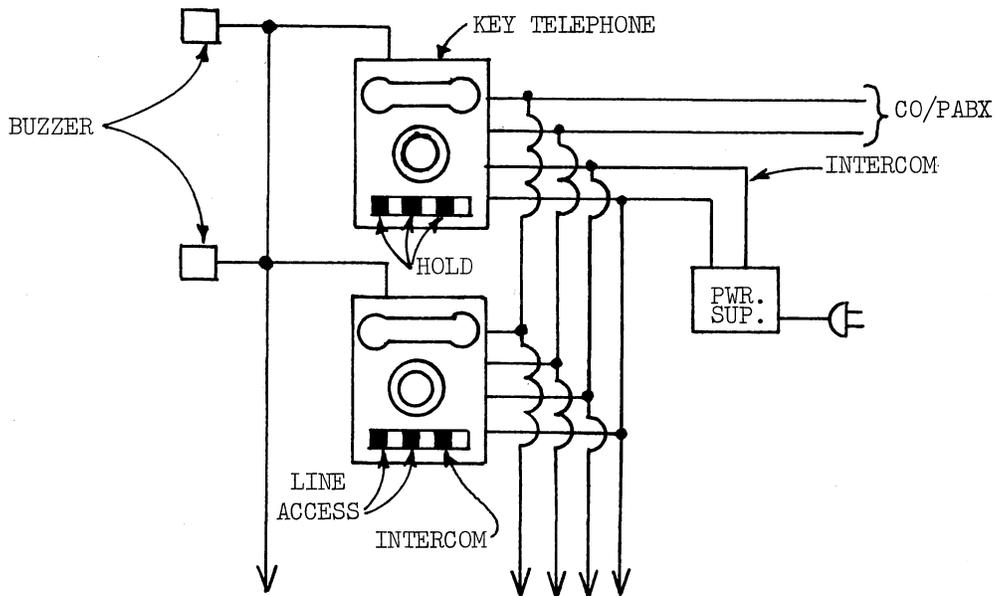
4.2241 The mode of operation of the business frequently requires extended discussion between the manager and one of the office staff while several customers are in the office. As a result and in view of the projected expansion, a Type B system and a private talking link intercom with two talking links is recommended.

4.2242 By adding a "meet me" conference feature, which permits several intercom stations to be bridged together and bridged to an outside line, outside calls can be forwarded to the elevator. In addition, this arrangement prevents the use of the telephone at the elevator to place unauthorized outside calls.

4.2243 A check with personnel at the company reveals that the area's power supply can be unreliable, with service being frequently interrupted. In order to provide limited service during these outages, provisions must be made to provide ringing during power outages.

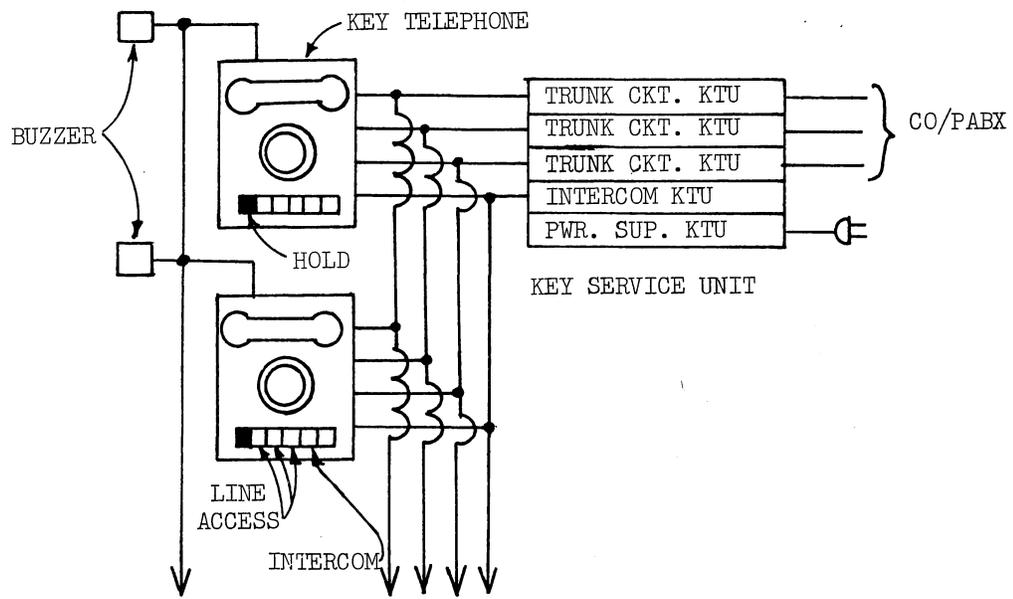
4.225 Off Premise Stations. With the system as presently engineered, only the intercom station at the elevator is far enough from the equipment cabinet to require this special treatment. Care must be taken to furnish station protectors at both ends of the cable run between the key service unit and this extension.

4.226 Cable Runs and Loop Limits, and Key Service Unit Location and Power Supply. These parameters are fairly straightforward in this case, so no further discussion will be added to that in Paragraphs 4.16 and 4.17.



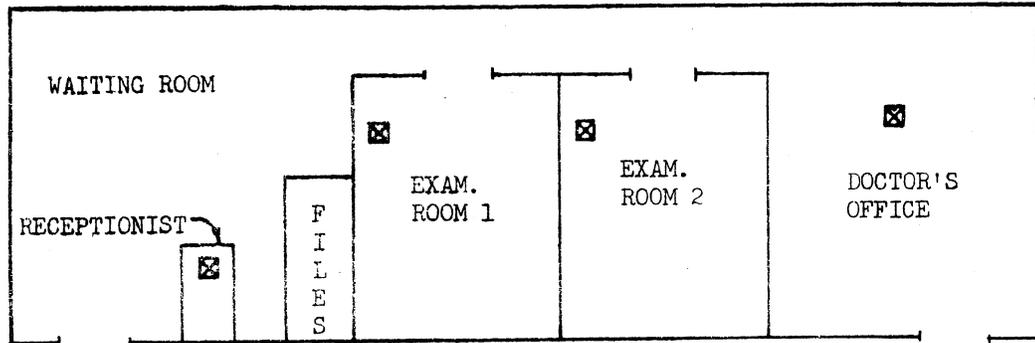
TO ADDITIONAL BUZZERS TO ADDITIONAL STATIONS

FIGURE 1
TYPE A KEY TELEPHONE SYSTEM



TO ADDITIONAL BUZZERS TO ADDITIONAL STATIONS

FIGURE 2
TYPE B KEY TELEPHONE SYSTEM



DOCTOR'S OFFICE
STAFF:
1 DOCTOR
1 NURSE
1 RECEPTIONIST

INSTALLATION:

- 4 MULTILINE TELEPHONE SETS (☒)
- 2 CO LINES
- 1 COMMON TALKING PATH INTERCOM
- EXTERNAL BUZZERS AT EACH STATION

FIGURE 3

SAMPLE TYPE A KEY TELEPHONE SYSTEM INSTALLATION

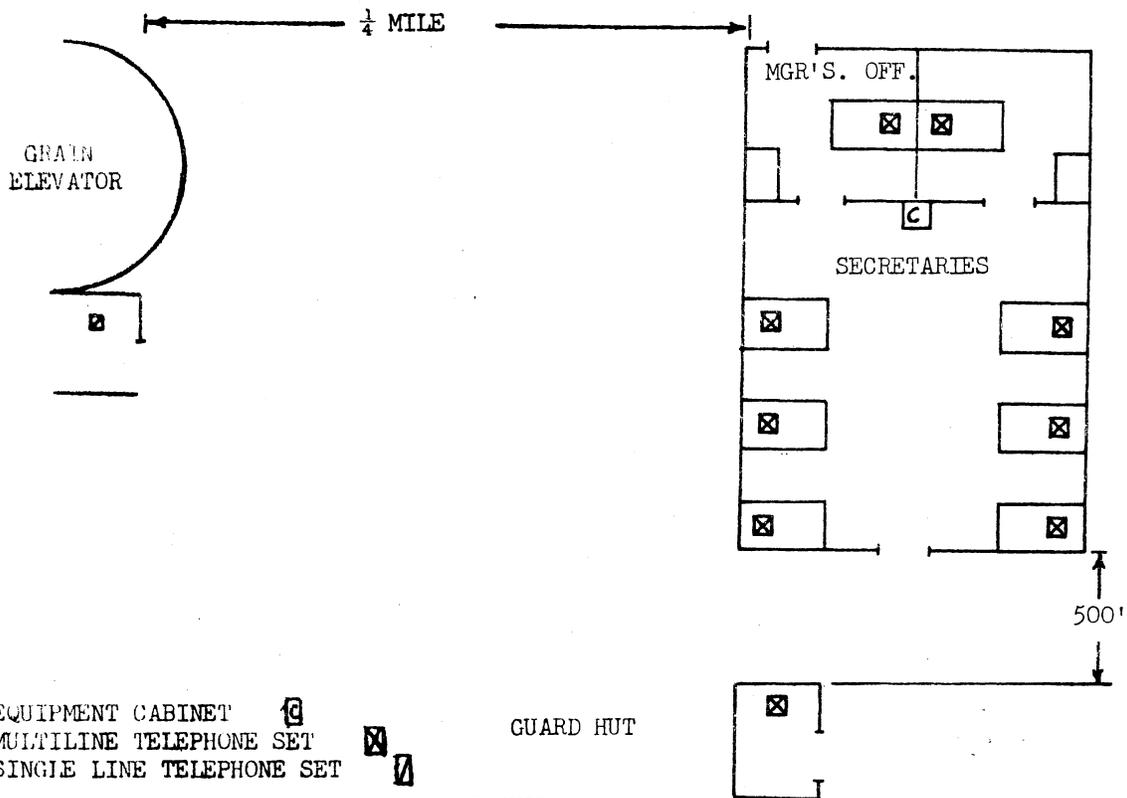


FIGURE 4

SAMPLE TYPE B KEY TELEPHONE SYSTEM INSTALLATION